Excavating in breccia: new methods developed at the Benzú rockshelter

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Method

Excavators examining breccia deposits are faced with the prospect of extracting finds from a material akin to concrete. Nevertheless such deposits are sometimes the only witness of early Palaeolithic occupation. Our inventive authors put aside the hammers, acids and explosives of earlier days, and used quarry techniques to cut the breccia into small blocks, which they then freed from their finds in the laboratory, using tools developed in palaeontology. As a result, they gathered a huge harvest of stone tools, bones and shells. It all goes to show that archaeological excavation is an exercise of infinite variety: to every problem, its solution; to every terrain, its method.

Keywords: North Africa, Ceuta, Benzú rockshelter, Palaeolithic, excavation method, breccia

Introduction

Breccia is a densely consolidated material consisting of angular fragments of rock cemented in a matrix (Loucks 1999; Loucks & Mescher 2001). Sedimentary breccias typically form within and on the talus of limestone caves as a result of water flow, and may be regarded as lithified colluvium. They can continue to form after human occupation, and thus may contain artefacts. The problem of excavating in breccia is basically one of defining an archaeological sequence in a deposit that resembles concrete.

Breccia sites are relatively abundant in the world (Latham 1999), occurring in karst environments associated with caves and rockshelters. Well known examples include Limeworks Cave, Makapansgat, South Africa (Hill & Forti 1997), Zhoudoudian, China

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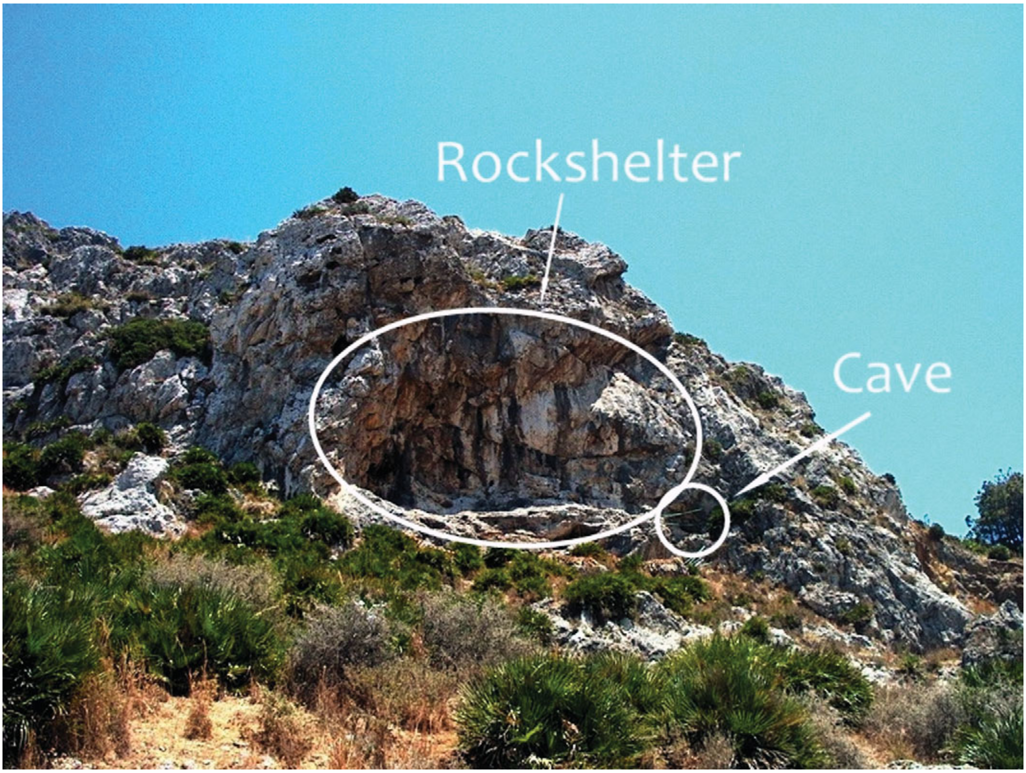

Figure 1. View of Benzú rockshelter and cave.

(Wu & Dong 1985) and Red Barns, Portchester, Hampshire, UK (Wenban-Smith *et al.* 2000). At Grotta di Porto Infreschi, Camerota (Italy), a series of marine conglomerates containing *Spondylus* (probably of the Tyrrhenian geological stage) was succeeded by alternating levels of red clay, breccias, pyroclasts and stalagmitic crusts, sealed at the top by colluvial deposits and rock falls with a Mousterian industry (Bachechi 1989–1990). Examples from the Iberian peninsula include Gibraltar-Beefsteak Cave (Giles *et al.* 2007), Rosia Bay breccia (White 1913; Finlayson *et al.* 2006), Tajo de Doña Ana, Alfarnatejo (Ramos *et al.* 1995–1996) and Cueva del Ángel, Lucena, Córdoba (Barroso *et al.* 2011), in Andalucía, and Figueira Brava Cave (Portugal), a rockshelter of the Middle Palaeolithic (Upper Mousterian), dated to between 30 and 31 ka (Antunes 1990–91; Antunes & Cardoso 1992).

Excavators have been obliged to work round the densely cemented breccias, or attack them with heavy machinery and even with low-power explosives. In such cases, the recovery of archaeological material has naturally been poor. In this paper, we describe a new approach to the problem, developed during research at the rockshelter of Benzú.

The Benzú rockshelter

The archaeological site of Benzú is situated on the coast of North Africa, on the south side of the Strait of Gibraltar in the autonomous Spanish city of Ceuta. It is located about 230m from the present shoreline (Figure 1). The Palaeolithic rockshelter, discovered in 2001 (Bernal

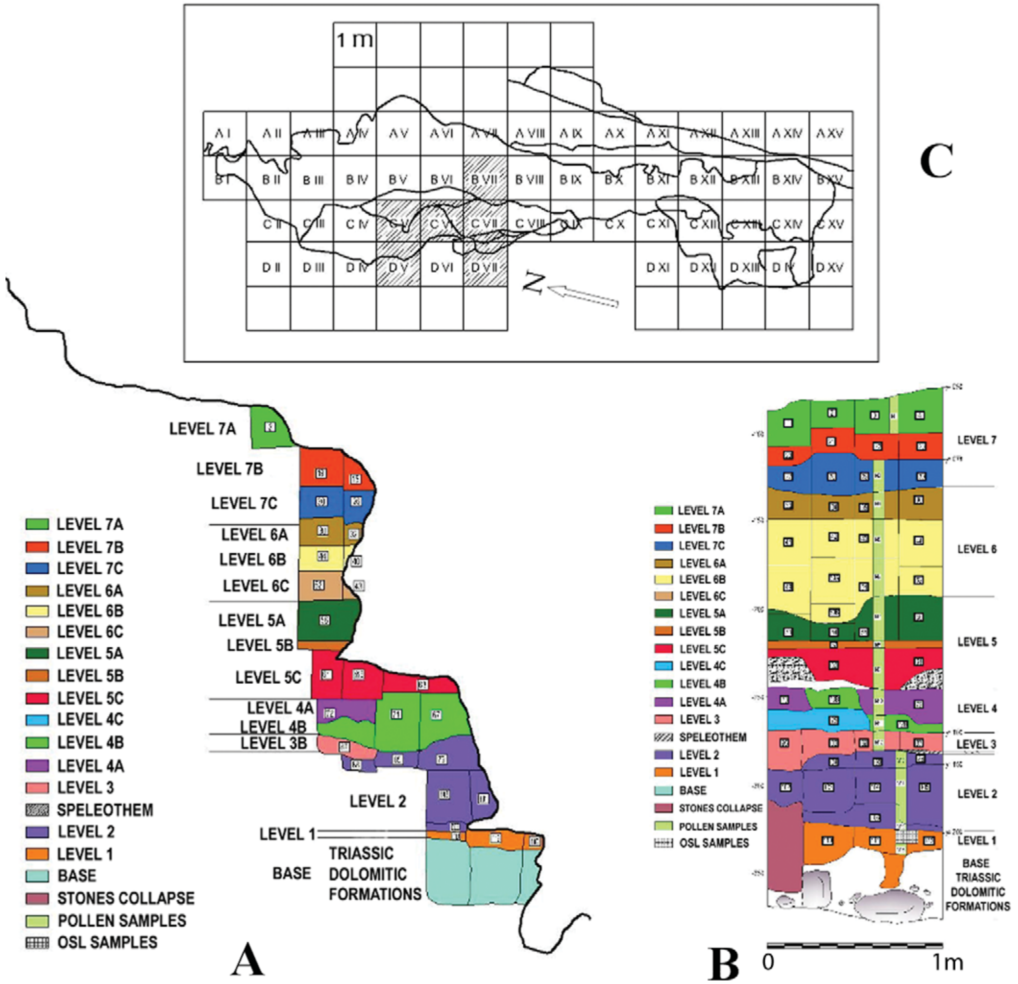

Figure 2. Excavations at Benzú: A) schematic section of the breccia front, vertical section of BVII-CVII-DVII squares, seen from the north; B) vertical section of the breccia levels in BVII-CVII-DVII squares, seen from the east; C) grid plan of the rockshelter breccia (the excavated sections are shaded). Vertical profiles are shown in (A) and (B).

2001), contains an archaeological deposit mostly consisting of limestone breccia, of a high degree of compactness and hardness. The shelter was formed through erosion before Isotope Stage 9 and any human occupation (Abad *et al*. 2007). It may have lost its overhanging cornice during the Quaternary (Durán 2003; Ramos & Bernal 2006; Ramos *et al.* 2008). Adhering to the rock wall of Triassic dolomite is a deposit of highly consolidated calcareous breccias. This was defined in plan and section (Figure 2), and subsequently resolved into ten stratified levels (Table 1). Geological studies of the sedimentation (Durán 2003) show that stratigraphic levels 1 to 7 contain evidence for early human occupation. This took the form of a Mode III-Mousterian knapped stone industry, with chronologies ranging from 70–250 ka (Durán 2004; Ramos *et al.* 2008), and include indications of marine resource exploitation (Ramos *et al.* 2011). Lithics, animal bone and shells (malacofauna) all survive well within the breccia (Figure 3).

Table 1. Stratigraphic sequence, types of sediments and chronology of the Benzú rockshelter (after Ramos *et al.* 2008).

Strata	Type of sediment	Chronology	Observations
10	Upper speleothem	(Th/U) IGM: ±70 ka	Seals the whole sequence
9	Breccia with clasts		
8	Micrite		
7	Breccia cemented with dolomite blocks		
6	Micritic mud		
5	Breccia of sands and muds	(OSL) Shfd020136: 168±11 ka	OSL datation of the upper part of the strata
4	Breccia of clast and muds		
3b	Speleothem	(Th/U) IGM: 173±10 ka	Thin speleothem
3	Micritic mud		
2	Breccia of clast and muds	(OSL) Shfd 020135: 254±17 ka	OSL datation of the upper part of the strata
1	Breccia		
0	Rock (dolomite)		

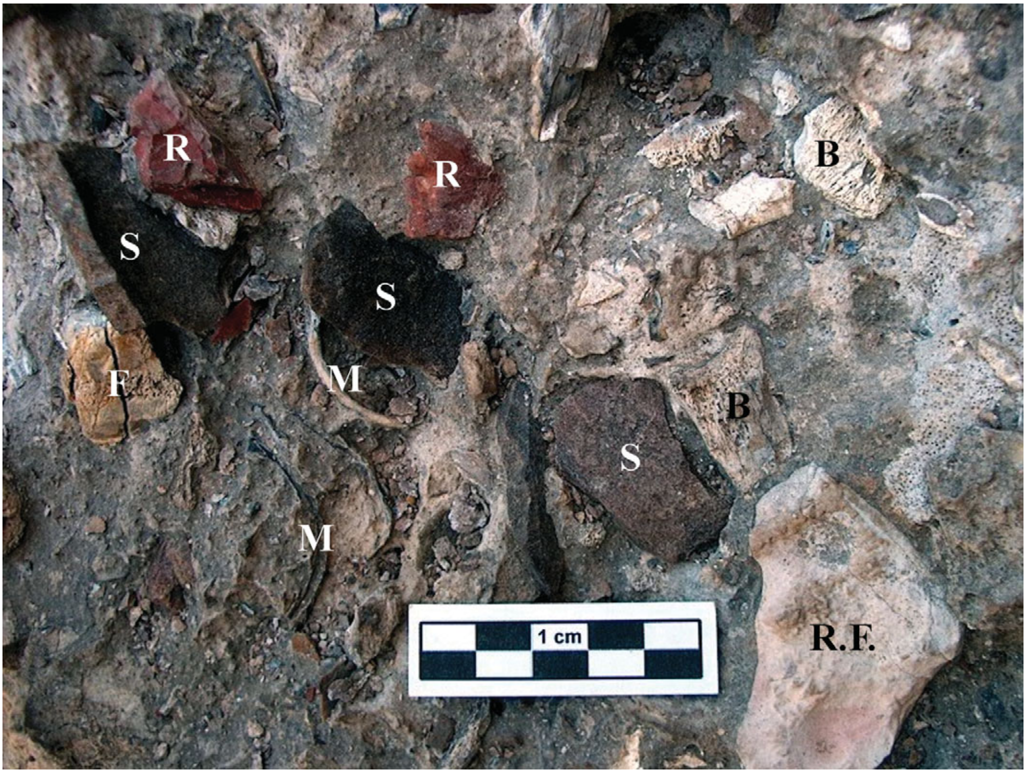

Figure 3. Aspect of the lithic industry and faunal remains in the breccia (B = bone; R = radiolarite; F = flint; S = sandstone; RF = rock fragments; M = malacofauna).

Figure 4. The front of the breccia deposit, showing the area of extracted blocks in June 2003.

Methodology

The rockshelter measured 15.52 × 6.20m, and the top surface of the breccia deposit occupied an area of 61.2m^2 in plan (Figure 2C). Our methodology was developed over six seasons between 2002 and 2008. In 2002, the upper level of the deposit (Stratum 7) was defined (Ramos *et al.* 2003), and a 25cm grid laid out on its upper surface. From this surface we first attempted vertical excavation, using chisels and hammers. However, these tools also fractured the siliceous minerals and rocks, such as flint, radiolarites and sandstones that constituted the artefacts (Chamorro *et al*. 2003; Chamorro 2004; Domínguez-Bella 2004; Domínguez-Bella *et al*. 2006). We then applied hydrochloric or acetic acid in an attempt to loosen or dissolve the calcium carbonate ($CaCO_3$) of the breccia. This was not only very slow (and dangerous for the health of the excavators), but also affected the surface of the lithics, impairing subsequent chemical or wear analysis. The acid also attacked remains of organic origin, such as malacofauna (mainly composed of $CaCO_3$) and the skeletal remains of animals or humans.

Following this frustrating experience, we developed a different methodology inspired by methods used for the extraction of stone in quarries and the extraction of fossils from stone. The new strategy was to extract the deposit in small blocks (Stage 1) and then disaggregate them in the laboratory (Stage 2). We began the 2003 campaign (Figure 4) equipped with

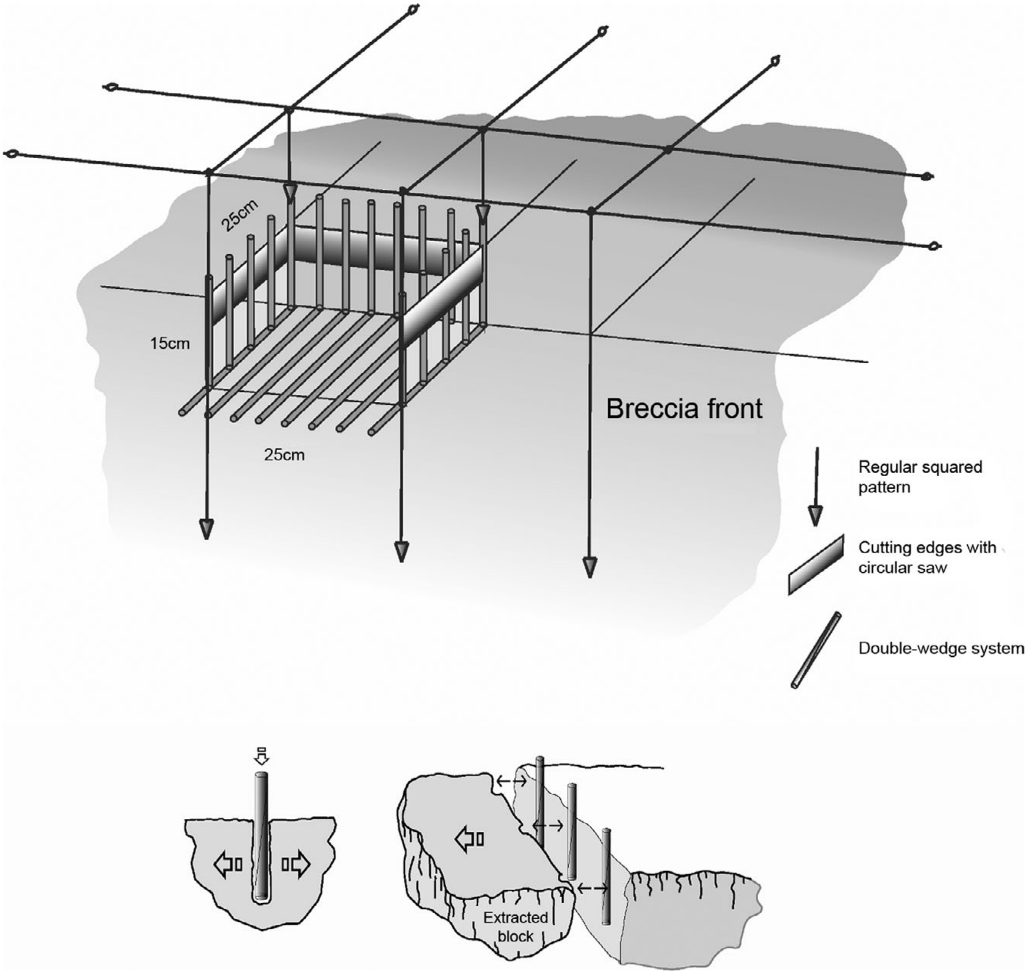

Figure 5. Stage 1: extraction of the blocks. Rows of holes are drilled on four sides and beneath, and the block extracted using double-wedges hammered into the holes.

newly-purchased power drills for stone with bits of 20mm diameter, a portable circular power saw with diamond blades of 20cm, steel wedges, and the traditional hammers and chisels.

Stage 1

Blocks 25 × 25 × 15cm were marked out and an initial cut made along all four sides and beneath (from the side) using a diamond tipped circular saw, capable of penetrating about 7cm into the breccia, with a blade thickness of 4mm. Rows of holes were then drilled with a tungsten carbide 15mm diameter bit along the same axes, to the full depth required (Figures 5 & 6). Wedges and double-wedges were inserted in these holes, and hammered until the


Figure 6. Drilling the holes.

block fractured along the cut lines (Figure 7). Once cut free, the blocks were labelled with their grid co-ordinates and orientation and packaged for shipment to the laboratory.

The same method was then applied to stratum 6. Strata 5 and 4 proved more workable than the others, and could be excavated with standard procedures (small trowels and brushes). From the third excavation campaign (2004) the method was slightly modified, applying a new system of wedges and double-wedges created by our collaborator A. García Cañizares, based on ideas discussed with the group speleologist, A. Luque. Strata 3, 2 and 1 were excavated, reaching the floor of dolomite rock, which we believe represents the bedrock of the original cavity in this area of the rockshelter. Thus the full depth of the stratigraphic sequence was retrieved in blocks (Figure 8, see also Figure 4).

Stage 2

In the laboratory each block was carefully unpacked and disintegrated to recover the assemblages locked inside them. The coarse fragments of breccia were removed using hammers and conventional small chisels (Figure 9), releasing material containing bone, shell and artefacts. These were then cleaned of breccia with Chicago Pneumatic® compressed air tools (Figure 10), as used in palaeontology. We used different types of percussion tips and tools such as microdrills (Dremel®), always working under magnifying glass visors. Faunal

Figure 7. The double-wedges (left) inserted into the drilled holes (right).

Figure 8. Vertical surface of the breccia deposit, after the removal of several layers of blocks.

remains were consolidated with Primal, diluted to 50 per cent. Overall, the procedure resulted in a suite of assemblages related to a stratified sequence determined by the original position of the block.

Figure 9. Stage 2: in the laboratory. Small chisels are used to break up the block and separate the visible finds from the breccia.

Critique

The volume of excavated rock lost or destroyed by this method largely corresponded to the volume of holes made in the breccia to accommodate the wedges and of the cuts performed with the circular saw. This was calculated to be up to 4.41 per cent of the recovered block, which is considered acceptable, especially given that this type of material has often not been excavated at all.

However, the method has not succeeded in recording the presence of structures or addressing the horizontal use of space, which would throw more light on the organisation of the human groups and their activities. This does present some problems, particularly due to the survival of breccia deposits themselves, which have often disappeared due to erosion

Figure 10. Using micro-percussion tools (Chicago Pneumatic®) for small-scale disintegration and recovery of lithic and faunal remains.

in recent millennia. The recovery of botanical remains is also a challenge. A comparison can be drawn with the better-defined Neolithic occupation excavated in a cave immediately adjacent to the rockshelter (Vijande *et al.* 2008). Here the sandy sediment permitted more familiar stratigraphic excavation and three-dimensional finds plotting (Vijande 2011).

Conclusion

In spite of the intractable nature of the breccia deposit, more than 50 000 finds were recovered in sequence, informing the economy and society of hunter-gatherer groups through the Middle and Upper Pleistocene. Studies are currently being carried out on a wide range of archaeological materials (microvertebrates, malacofauna, large vertebrates, pollen, birds and rodents), including dating using TSL and U-Th techniques (Ramos *et al.* 2008, 2011). This rich assemblage shows that the methods applied are effective and may have applications at other archaeological sites in different parts of the world.

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